THE MODEL ENGINEER

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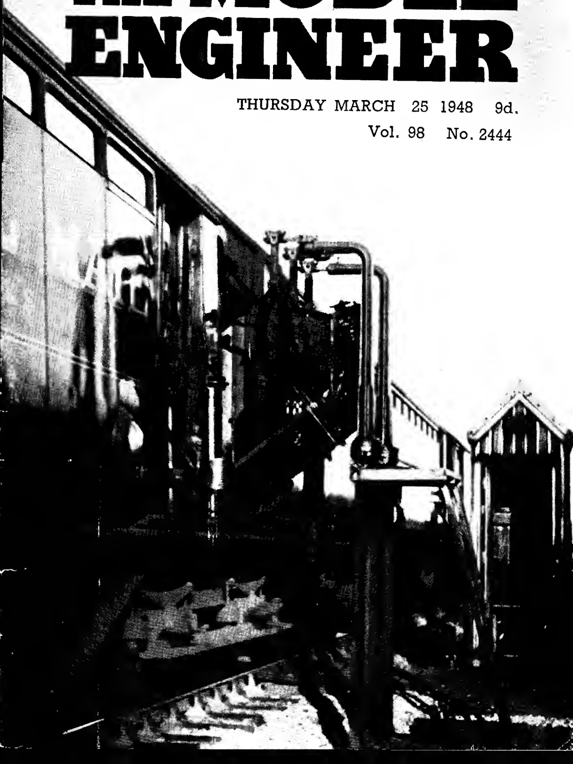


The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

25TH MARCH 1948 VOL. 98 NO. 2444

SMOKE RINGS

Our Cover Picture

● THE TRAVELLING Post Office, as a pick-up and set-down mail train is usually termed, has a fascination all its own, particularly to the line-side spectator. Such trains usually run at night, or in the late evening, and can be easily distinguished from other trains at a distance by reason of the fact that the lamps carried on the near-side of the vans are lit up. During the period of British Double Summer Time, however, it is possible to photograph the 8.30 p.m. "West Coast Postal" at speed, and this week's cover picture is an action shot of this train just about to pick up the mail-bag from the line-side apparatus at Harrow. The photograph was taken by Mr. C. R. L. Coles, who timed it nicely ; and as the speed of the train must have been at least 60 m.p.h., the almost total absence of any sign of movement bespeaks an excellent camera, even though the picture is actually an enlargement of a portion of the negative.

"The Model Engineer" Exhibition, 1948

● THE NEW Royal Horticultural Hall, Westminster, will again house THE MODEL ENGINEER Exhibition, which takes place in August from the 18th to the 28th inclusive. One of the highlights this year will be an International Section for which countries have been invited to send a limited number of representational models. It has been arranged in order to show that model craftsmanship is world-wide without boundaries, and to give the British public a chance to see models from overseas. These models will not compete with British models. In this connection the Swedish model paper *Teknik for Alla* has kindly offered to arrange all the Scandinavian exhibits and to hold a pre-exhibition in Sweden to choose the best models for our own "M.E." Exhibition in London. Competition forms will be ready early in April and clubs are reminded of the Club Team Section. Clubs and societies wishing to take stands should make application early. These stands are erected and loaned free of charge by the organisers, only a certain number of clubs can be accommodated. All enquiries should be addressed to :—The Exhibition Manager, THE MODEL ENGINEER Exhibition Offices, 23, Great Queen Street, London, W.C.2.

Easter at Gosport

● THE GOSPORT SOCIETY is to hold a local exhibition at the County School on the Monday and Tuesday in Easter week, from 10.30 a.m. onwards. The Mayor of Gosport will open the show on the Monday morning, and the proceeds will be devoted to his War Memorial Fund.

A "Midge" at Andover

● THE ACCOMPANYING photograph of an unfinished "Midge" will be of special interest to south country live-steamers, as the engine itself, in a more advanced form, will be a feature of the forthcoming Andover Society's Easter-week exhibition to be held at the Guildhall. This will be the third annual show by the Andover Society and promises to be quite up to the usual high level of interest. The "Midge" locomotive represents two years' work of Mr. W. H. Crothall who has quite a local reputation, not only for his constructive work, but for his enthusiasm for all model engineering interests in the southern counties.

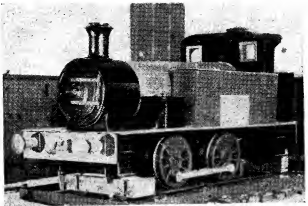


Photo by] [*Peter Fry, Andover*

W. H. Crothall's modified "Midge"

Club Insurances

● MY RECENT note on the desirability of clubs taking out insurance policies to cover workshop accidents and other risks has brought an interesting confirmation from Mr. G. A. Flanagan, the Chairman of the North London Society of Model Engineers. He writes :—"As chairman of this society, I write to express my interest in the article which appeared in this week's issue of THE MODEL ENGINEER in respect to insurance. Some time ago I was able to secure for the society a very satisfactory insurance policy, which gives adequate cover in respect to third party claims, together with a 'so valued' cover in respect to models owned by individual members, also property belonging to the society, i.e. portable track, etc., loss or damage, howsoever caused, from the time that the models leave the place where they are normally kept, until safe return thereto. The cost of this insurance is almost negligible when spread over the membership of the society, whilst the safeguards which it affords both to the society and to individual members is most desirable. I mentioned this matter to the Secretary of the Ramsgate club a short while ago, who, I understand, has now taken out a similar comprehensive policy."

"The Model Engineer" Got There

● IN A note of congratulation on our 50th anniversary, Mr. L. G. Bateman of Swansea, Ontario, writes that all during the war period not more than eight issues of THE MODEL ENGINEER failed to reach him in Canada. He has, fortunately, been able to secure the missing numbers, so his set which dates from 1921 is now complete. He considers that THE MODEL ENGINEER is without an equal.

Traction Engine Details

● A CORRESPONDENT who is a keen traction-engine enthusiast writes :—"I think the greatest difficulty with the traction modeller is the lack of information *re* the design of compound cylinders showing steam passages, etc. gear changing arrangements, compensating gear, and correct details of pitch and number of teeth in gear wheels for various speeds. To quote an example, I have been trying for two years to obtain a sketch of gear changing arrangements for a 'Foster' type 3-speed road locomotive without success. Incidentally, many people I am told, consider this the finest type ever built." Can any reader help this correspondent either by supplying him with a suitable sketch, or referring him to any drawings which have been published?

Triple-geared Lathes

● MR. H. PHARE of Torquay writes :—"I have followed the correspondence regarding triple-geared lathes and think the following may add to the interest. About 1902 I was asked by a friend to inspect a lathe offered for sale at Plymouth. Going there we found it to be triple-geared and the maker's name Broadbent. So far as I can remember centres were about 6 or 7 in. and the bed about 6 ft. long. The price asked was £12, and from a superficial examination the condition appeared to be very good. The reason for the low price became apparent when a closer examination was made and one standard was found to be fractured. The lathe was not bought because welding was not easily effected in those days. I learnt from the seller that the lathe came from Devonport dockyard and had been used aboard ship. I am always greatly interested in hearing about these old-time machines. I knew a man in this town who had a 6-in. Whitworth lathe which had been shown in the 1851 Exhibition in London." I think it is quite correct that many of these stocky triple-geared tools were designed for use in the workshop attached to engine rooms at sea. They could deal with emergency repairs of a heavier character than could be coped with by lathes of the ordinary type, and the compact design enabled them to be fitted into the restricted space usually available for machine tools in the neighbourhood of the main engines.

Percival Marshall

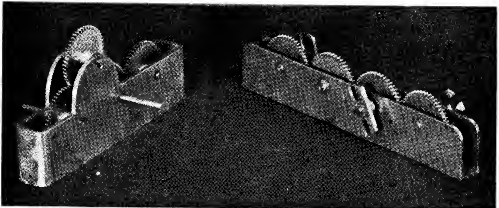
*Swords into Ploughshares

Hints on the adaptation of "surplus" war material for model engineering or utility purposes

Gearing and Mechanism

by "Artificer"

APART from the instruments and apparatus which can be readily adapted or converted to new purposes, more or less in their entirety, there are many others for which it is difficult to see any application, other than that for which they were specifically designed. Many of these devices, however, contain useful components, or complete mechanical or electrical units, and are therefore mainly of interest for their "break-down" value.



Gear trains for driving twin propellers in a model boat—an example of the application of small gears, as supplied by Messrs. H. Franks Ltd.

It has already been observed that small electric motors of various types are extensively used in mechanisms for automatic or remote control; and it is hardly necessary to discuss further the way in which these can be applied. Most of them are highly efficient, but suffer from the disadvantage—from the model engineer's point of view—that they are designed to run on voltages not readily available from small batteries or other convenient power sources. Apart from rewinding, there is not much that can be done about this, unless the purpose for which the motor is to be used justifies installing a special power supply, such as a 24-volt accumulator or (in the case of motors which will run on a.c.) a transformer of similar output.

Gearing of all kinds is a feature of many pieces of surplus apparatus, and here is something which is directly useful to most model and experimental engineers. In many types of models, it is necessary to use gearing—sometimes a good deal of it, as, for instance, in a model traction engine, a crane, or a transporter bridge—and everyone knows how expensive a proposition it is to have gears made to order. Certain types and sizes of gears are stocked by model dealers, and cheaper gears have in the past been available as accessories for constructional toys; but while these have usually been reasonably priced, in relation to their quality, their cost often represents a large proportion of the total material cost in constructing a model. By utilising gears from surplus equipment, where possible, costs may often be substantially reduced, and, moreover, the quality, both of material and workmanship, of these gears is usually extremely high. The only disadvantage is that the range of gears available may be limited, but if one has an exact knowledge of essential requirements in a particular case, it is often possible to find a piece of mechanism, containing the required gearing, and obtainable at a low price.

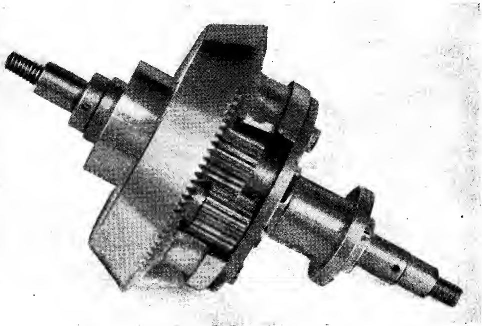
Some advertisers in THE MODEL ENGINEER have already announced that they have stocks of gears from these sources available, and inspection of some of these gears has removed any possible doubt as to their adaptability and usefulness. A very wide range of gears is offered by Messrs. Educational Models Limited, Teddington, Middlesex, whose products have been referred to in previous articles in this series; the gears range in size from about 6 in. to ½ in. diameter, and from 20 to 40 d.p., all types, including spur, bevel, worm and spiral gears, in bronze and stainless steel.

For the smaller sizes of gears, down to 48 d.p., mostly in steel and hard brass, a very wide selection is offered by Messrs. H. Franks, of New Oxford Street, London, W.2, and the price of

* *Continued from page 274, "M.E." March 11, 1948.*

these is extremely low, ranging from about 3d. upwards, but we are asked to state that while any of these gears can be supplied over the counter, mail orders for very small amounts cannot be entertained owing to the cost of packing and clerical work. Parcels of assorted gears can be supplied from 7s. 6d. upwards, plus postage. An example of the way these small gears can be employed in model work is shown in the model tractor or other road vehicle. The units offered by Messrs. Franks are much smaller, but operate on the same principle.

It may be observed that differential gears have many other uses besides compensation for the unequal travel of vehicle wheels when rounding curves. They are very extensively used in calculating and integrating mechanisms, such as watt-hour meters, range-finding and course-



A differential gear unit supplied by Educational Models Ltd., Teddington

boat propeller transmission gears illustrated. These were made from gears obtained from Messrs Franks, by Mr. G. H. Davis, of Brighton, their purpose being fairly clear to most readers: namely, the drive to twin propellers from a single engine or electric motor. In one case, the gear centres are all in line, but in order to reduce the distance between propeller shaft centres, the second gear train has the intermediate gear displaced upwards; contra-rotating propellers are used in both cases, but if the propellers are to be run in the same direction, only three gear wheels are necessary. The train may with advantage be completely enclosed, and run in an oil bath.

Differential Gears

Both the firms mentioned above can supply complete differential gear units, both of the bevel and spur pinion types. An example of a differential unit sold by Educational Models Limited is illustrated here; the gears are in phosphor bronze and include, in addition to the spur differential gears, a large bevel crown wheel for primary drive, the bevel pinion for which is also available. This unit would be highly suitable for incorporation in the transmission gear of a model computing instruments, where they combine the additive or substractive effects of two separate movements. A much less familiar use of this form of gearing is for timing adjustment or "phase shifting" in synchronised mechanism, such as the time base of an oscilloscope or the sampling valve of an instantaneous pressure indicator.

One very important application of the various types of gears, which cannot be too highly stressed, is in schools and educational establishments, where they can be used to demonstrate basic principles of mechanics, leverage, laws of motion, etc. A number of models specially arranged for these purposes have been produced by Educational Models Limited, but the simpler forms of demonstration mechanisms are quite easy to construct with simple equipment, once the gears are available.

A pair of small gears, held in a small frame so as to mesh together, and put into the slide carrier of an ordinary lecture lantern, would admirably serve to explain tooth forms, and the effects of errors in accuracy or meshing, by using the lantern as a "shadow projector" to magnify the gears to a very large scale. On the principle that "two minutes' demonstration is worth two

hours of explanation," it is surprising that educational authorities are still slow in adopting methods such as these in teaching technical subjects.

Time Mechanisms

Timing and "delay action" gearing is used in many forms of apparatus; it ranges from the simple air or fluid dashpot device to very elaborate sensitive governors and escapements. The use of the dashpot in conjunction with gyroscopic and pendulum instruments has already been referred to; in this case it acts only as a steadying or damping device, but in some instruments a long-stroke dashpot plunger is used to provide a more or less definite period of delay. A dashpot of this type might be adapted to control a throttle-opening device on a model speedboat, or if it is capable of being adjusted to a sufficiently slow rate of movement, to serve as a time switch on model aircraft.

It is well known that bombs and other explosive devices are often fitted with most elaborate time control devices, including delicate clock mechanism, the destined destruction of which seems to be sheer wicked vandalism to the lover of fine craftsmanshp. In some cases, however, a much simpler but still highly ingenious mechanism is used for the same purpose, but as comparatively few of these devices have escaped the fate for which they were designed, there is not much point in describing them in detail.

One example of a delay-action device which, it is understood, was used in submarine depth charges, was submitted by Mr. Hogben; it consists of a clockwork gear train with a "fly" or fan brake, operated from a rack and ratchet pinion, presumably from some external source of power such as a spring or weight. The meticulous care taken in ensuring smooth and certain action of this device is noteworthy, and without doubt necessary, when one considers the possible effect of its premature release. It would be possible to adapt this train of gears, almost *en bloc*, to the going or striking train of a clock, the motive force being applied by a weight, acting on a drum fitted to the rack pinion shaft.

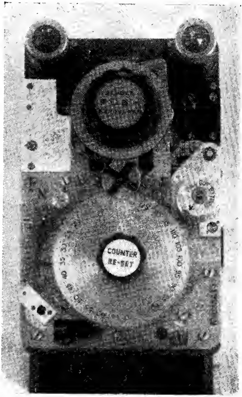
Camera Control Units

These devices are offered for sale by several advertisers in THE MODEL ENGINEER at present; there are several types differing not only in details of design and construction, but also, to some extent in function. They were, as their name implies, used to control the setting and shutter release of the automatic cameras employed in aerial photographic reconnaissance, and in some cases to synchronise the shutter opening with the discharge of flash bombs for night photography. Although essentially complete pieces of apparatus in themselves, they normally only function in conjunction with the camera and its driving motor.

In all cases, the control units contain a very ingenious chronometric timing device, driven by an electric motor, and a setting device whereby this can be brought into action for a definite length of time. Some types also contain an electro-magnetically operated counter dial which records the number of exposures made by the camera.

The chronometric system which is the principal feature of this device consists of a lever escapement with balance wheel and spring, essentially similar to that of a watch or portable clock, but on a much larger scale; for instance, the balance or "hair" spring is larger and heavier than the mainspring of a small watch. The escape wheel shaft carries a small worm-wheel and a friction clutch, which normally transmits the driving power from a worm on the motor shaft, and also a pinion which gears with the period-setting mechanism. During the time the motor is in operation, the escapement works at a constant rate, the period of the balance being approximately ¼ second, or 240 per minute.

The method by which the operating period of



Camera control unit, with timing mechanism and exposure counter (cover removed), supplied by Aero Spares Ltd.

the device can be varied is so ingenious as to merit a brief description. Through the pinion on the escape wheel shaft, previously mentioned, motion is transmitted to two intermediate gear shafts, which in turn drive two concentrically-mounted large spur wheels slowly in opposite directions, the rear clockwise and the front anti-clockwise. Between these two gears, and on the same arbor, is frictionally mounted a radius arm having a trip device which controls two pawls or claws, one or other of which is in engagement with the teeth of one of the spur wheels. It also

(Continued on page 321)

Solenoids and Contactors

by H.C.W.

THE model engineer is likely to come, sooner or later, to the problem of remote control by electrical means. It may be the electrical control of a boat or car or a device for the remote operation of a camera shutter, but the requirements are very similar in that a means is required of producing mechanical movement by the remote control of an electric current.

There are quite a few snags in the design of such things, so that it is as well, before starting, to get the hang of the main principles involved. Perhaps the first thoughts would turn to the solenoid for a solution of the particular problem in hand, so we will consider that first. A solenoid is a coil of insulated wire, usually of copper, wound on a bobbin of insulating material, for support, which has a hole clear through the centre. Any schoolboy will know that if an electric current is passed through the wire, a magnetic field is created as shown in Fig. 1, and any piece of iron or steel will be drawn into the centre as shown in Fig. 2. It should be made clear, however, that the magnetic field is more dense inside the coil than anywhere else and that this density is increased many times by the presence of magnetic material such as iron or steel. Furthermore, there is a tendency for a piece of steel to align itself with the magnetic field existing at the point where it is situated and also for it to be drawn towards the place where it will have the greatest effect in increasing the magnetic field or where it will have the most lines of force passing through it. These tendencies can easily be demonstrated with a bar magnet and a compass.

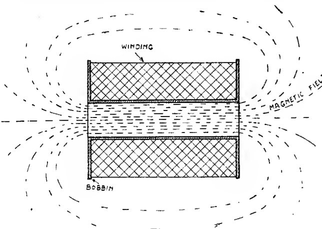


Fig. 1

Here then is a way of obtaining mechanical movement from an electric current. The iron core should be arranged part way out of the coil as in Fig. 2, for it should be realised that as the core is pulled out from the centre it is in a weaker field and the force tending to pull it to the centre is less. If it is too far out initially, there may not be sufficient force acting on it to be effective. Also the bar will only move to the centre and, if displaced beyond that point, there will be a force drawing it back again. This means that there is a definite limit to the amount of movement which may be expected from this type of solenoid.

Applications of the Solenoid

In fact, this design of solenoid is not very efficient at all and is not very often used, apart from a few toys of which, perhaps, the best example is the electrical reciprocating motor shown in Fig. 3. In this the current is switched on, by the making of the wiping contact on the crankshaft, for a quarter of a revolution twice per revolution, while the centre core or plunger is on its way from the extreme end of its travel to the centre position. It is then switched off again while the plunger is moving out the other side. This is quite an easy toy to make, and it can be made to run at quite an amazing speed.

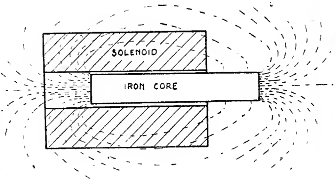


Fig. 2

For more important applications it is usual to increase the magnetic field by the inclusion of more iron in the circuit, as shown in Fig. 4, and the shrouding may extend all round the outside of the coil, in which case it is called a "pot"

magnet. By this means the magnetic field is very much increased over the open type of magnetic circuit and the lines of magnetic force external to the solenoid are reduced to a minimum. The core is a free fit in the open end and it may slide all the way in a brass tube. Examples of this type may be seen in the dipping devices on car headlights and on trafficators. The writer once made a small " pot " solenoid for remotely " tickling the carburetter " of an Austin 7. This was to save getting out and having to lift the bonnet each time this important operation became necessary.

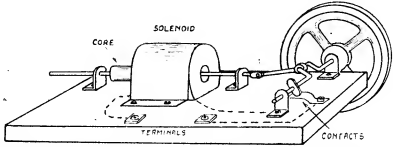


Fig. 3

The Moving Armature

More efficient still is the arrangement adopted in relays and contactors in which one part of the magnetic circuit, called the armature, is hinged and moves to complete the circuit when the current flows through the coil. These are really electrically operated switches, but the mechanical movement may be used for other purposes, apart from any electrical contacts which they may carry.

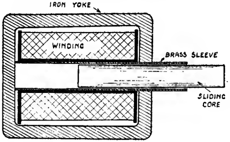


Fig. 4

One type of relay in common use, which can be obtained from the Government Surplus Stores quite cheaply, is shown in Fig. 5, and this form can be adopted where the movement required is fairly small and has to take place rapidly. Incidentally, this type of long-core relay can be modified in its operating characteristics by the addition of a single turn of solid copper fitted on the core in addition to the operating coil. This copper ring is often called a slug. With the slug arranged at the armature end, as in Fig. 6, the relay will be slower to release than to operate, but with the slug on the other end, as in Fig. 7, it will be slower to operate than release. These modified characteristics are more likely to be required for relay operation than for operation of some purely mechanical device.

The Contactor

A further type in this series is the contactor of which an example is given in Fig. 8. This is usually of more robust construction and designed to produce more mechanical force than any of the devices so far considered. It may be used to close a large switch or withdraw a bolt from a door or any similar operation. It has a very massive iron circuit, and hence a high magnetic flux density and efficiency. It has the usual characteristic that the mechanical force increases with the movement of the armature towards the core. The surfaces AA and BB should be machined quite flat and the armature should be hinged in such a position that the faces meet correctly when closed. When used on d.c. circuits there is often a tendency for these surfaces to adhere because of the residual flux which is left after the current has been switched off, and this is sufficient, when the surfaces are in contact, to hold the parts together. This may be overcome by interposing a thin piece of brass or copper foil between the faces.

This type of contactor lends itself very well to working on alternating current supplies, and for this purpose the core must be built up from laminations. It might also be convenient to use this method of construction even if the contactor is to be used on direct current.

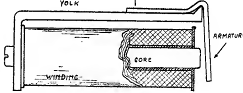


Fig. 5

Windings

Having decided on a suitable mechanical design for the particular purpose in hand, it becomes necessary to consider the type of winding to be employed. This will, of course, depend on the supply which is available, and we will take the d.c. case first. If the mains can be used, then the source of power, and consequently the mechanical force which can be obtained from it, will be, to a certain extent, unlimited. If, on the other hand, the power is to be taken from a small torch battery, then the power will be limited to 3 volts and about 0.25 amp. If the device is intended for only intermittent use, then the current may be increased to perhaps three times this value.

For a given type of core the magnetising force is proportional to the ampere turns in the coil. That is to say that ten turns carrying one amp. will have the same effect as one carrying ten amps. or one hundred carrying one tenth of an amp., and this must be borne in mind when the coil is being considered. Since there are so many variables in the type of core and length of operating air-gap, etc., it is very difficult to work out the exact number of turns required to produce a particular mechanical pull. A good practical

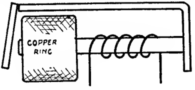


Fig. 6

method, however, is as follows. On the type of core selected, wind as many turns of thick wire as can be accommodated, say, 100, as an example. From an ample size of accumulator, such as a car battery, in series with a variable resistance and an ammeter, pass a current through the test coil. Adjust this current until it is sufficient to operate the relay or contactor mechanism against the normal load which it will have to carry. The product of this current and the number of turns on the coil will give the ampere turns required for the purpose in hand.

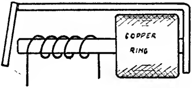


Fig. 7

The size of wire to be used for the final winding can be obtained from the formula

$$d = \sqrt{\frac{0.9 \times L \times AT}{10^6 \times V}}$$

in which d is the diameter of the wire in inches, L is the average length of one turn of the coil and is half-way between the length of the first turn and the length of the last turn, in inches. AT represents the ampere-turns required to operate the relay, as found by the previous experiment, and V is the voltage available for the job.

It will be clear from this that the number of turns wound on is not material to the operation, assuming unlimited current to be available. For example, if a relay has been wound "on spec," so to speak, and it is found that it is not strong enough to operate, it is useless to put on more turns of the same wire. This is easy to see if one thinks about it, for if the original number of turns be doubled, then the resistance would be approximately doubled and the current would only then be half the original value. Consequently, the product ampere-turns would remain the same. Failure to appreciate this has led to much confusion amongst amateur electrical engineers. The solution is to rewind with thicker wire or to use a higher voltage for operating.

Alternating Current

In the case of an a.c. contactor, the circumstances are rather different. The current through the coil is not determined so much by the resistance of the wire as by the magnetic flux through the core and the number of turns will generally be much less than is the case with d.c.

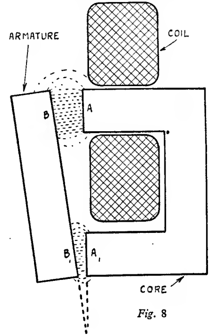


Fig. 8

The current, before the armature has closed, is much greater than when it is right home, due to the increased inductance of the coil in the latter condition. As a basis for the design of an a.c. contactor of the type shown in Fig. 8, the number of turns required can be taken as 10 per volt available, divided by the cross-section of the core in square inches, though it may be necessary to increase this figure for small relays and other types of core. It is usually necessary to fit a short-circuited turn of heavy copper strip round half the pole face of an a.c. contactor, as shown in Fig. 9, to form what is called a "shaded" pole piece. This is because otherwise, with the magnetic flux changing on a.c. and passing through zero 100 times per second, the pull on the core is weakened at these times and it tends to fall out or at least vibrate. The short circuited turn causes the flux in its half of the pole face to lag 90 deg., in phase, on the other half and so the flux never falls to zero over the whole pole face at once, and the contactor holds in more securely.

It is useful to know that most d.c. relays can be used on a.c. circuits by connecting a metal rectifier across them, as shown in Fig. 10, and

treating them as a.c. relays. Fig. 10 gives the conventional diagram of a rectifier connected bridge fashion, but it is most likely that the actual rectifier will appear as shown in Fig. 11 and this is given for identification of the connections. In any event, the direction of flow of current can always be checked with an ohmmeter.

Finally, when a solenoid or contactor has to operate from a limited supply, such as a dry battery, it is sometimes useful to fit an economy resistance. This arrangement is shown in Fig. 12 and adds resistance to the circuit of the operating coil just as the core goes right home. By this means a large current may be used to pull the core in, but as soon as it gets home the current is reduced to a value just sufficient to hold it there.

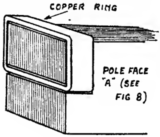


Fig. 9

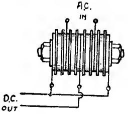


Fig. 11

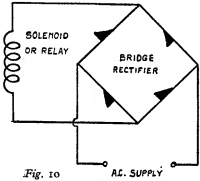


Fig. 10

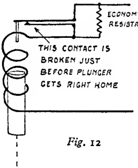


Fig. 12

Swords into Ploughshares

(*Continued from page* 317)

carries contact-operating members at both extremities.

In the starting position, the trip lever of the radius arm is resting against a fixed (but adjustable) stop pin towards the left-hand side, causing the pawl on the rear spur wheel to come into engagement. Movement of the gear train will thus cause the radius arm to move in a clockwise direction, until the trip lever encounters a second stop pin at the right-hand side, causing the rear pawl to release, and the front one to engage. The radius arm thereupon reverses its motion and travels back to its starting position. If the stop pin at the right were fixed, like that at the left, the period occupied in the two-way travel of the travel of the radius arm would be constant; but it is attached to an arm on the setting knob, which can be turned to vary the arc of travel, and therefore the time taken for the radius arm to complete its movement. The radius arm is also utilised to operate contacts both at the start and finish of its movement, which can be applied to operating the camera shutter, stopping the control unit motor, and showing a signal light on the panel when the camera is ready for use. Individual exposures may be made by pressing the centre of the time control knob (or in some cases a separate push-button is provided). The normal range of time provided for automatic operation of the camera is between 5 and 50 seconds, and in the case of the control used in connection with the release of flash bombs, the camera can be timed to operate at the exact time, after the release of the bomb, for which the fuse of the latter is set. This is usually calibrated in terms of thousands of feet drop.

The camera control unit, or its main essential mechanism, could be adapted as a "process timing" device of any kind, and would require no alteration for operations within its normal range of time adjustment. Alterations could, however, be made which would enable it to run continuously for periods of any length, and to operate contacts at the end of any specified period of time. If the driving motor cannot be used, due to the lack of suitable current supply (standard ratings are 12 and 24 volts d.c.), it would be quite practicable to drive the time mechanism by means of a weight, or possibly a spring.

(*To be continued*)

"Dignity and Impudence"

by "L.B.S.C."

YOUR humble servant has been "a bit off colour" the last week or so, and hasn't been able to finish the next batch of drawings for the 5-in. gauge locomotives; so let's have five minutes in the lobby by way of change. The merry old tea-bottle is still going strong, thanks to a kind friend who included the needful in a parcel sent from overseas. Well, as I remarked once or twice before, if a letter or package ever comes through the letter-box of our hacienda with a certain party's writing on it—his moniker is the oldest in the world—the contents are sure to be interesting. The latest, which arrived a few days ago (time of writing) contained the reproduced photograph and amusing imaginary dialogue. A friend presented Mr. Adams with a small toy locomotive of a type contemporary with young Curly's "Ajax." She is "Jerry-built," and apparently came from the Nuremberg firm where the "Vulkan" engines were made, as some of the parts are very similar. She was originally $2\frac{3}{4}$-in. gauge, but was easily reduced to $2\frac{1}{2}$ in., as the original axles were long and set radially, to enable the engine to run around a small-diameter circle. I saw one or two of them working in shop windows in my childhood days, so you can bet the circle *was* pretty small! With a little titivating up, the weeny toy ran nonstop for nearly half-a-mile around Mr. Adams's big circle, the time taken being 13 minutes; the maximum speed attained was four miles per hour, not bad for such a little old caricature.

When placed in front of the big Mallet recently described, the "dignity and impudence" effect was so striking that it impelled our worthy friend to record the following imaginary conversation :—

Impudence : "Whatever can be that huge dark ugly thing that I see standing behind me ?"

Dignity : "What an impertinent child! You're a stranger on this line, and no doubt you came from a toyshop."

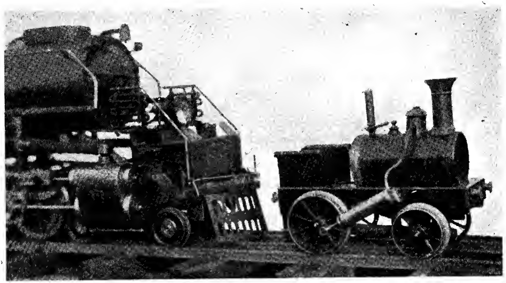


Photo by] *Extremes meet* ! [*Edward Adams*

Impudence : "Child, eh ? Well, just let me tell you I am ever so much older than you are! I can't think what locomotives of today are coming to, the airs they put on. I suppose you think that with all those wheels and blobs and gadgets, you're the last word in efficiency; but there's one thing that I can do better than you, and that is, go around a four-foot circle for half a mile on one firing. That's licked you hasn't it ?"

Dignity : "All you are fit for is to amuse the children, dolled up in shiny brass and red paint. Why, you can only pull a few toy trucks at most; look at the load I've been shifting !"

Impudence : That's only a matter of brawn, not brains. Dolled up, am I ? What about all your pipes, coils, platforms and all the rest of it—and your sand domes are only empty dummies !"

Dignity : "Anyway, I run in any weather, whilst a puff of wind blows your lamp out."

Impudence : "Maybe ; but I don't have to be fed with special coal, raked about, de-clinkered, have my flues swept, and need oil and water pumped into me all the time to keep me

going. You called me a toy, not realising how ingenious my makers were. For instance, my boiler shell is only as thick as a cocoa tin, so that it makes steam quickly, and as it is only attached to my frame at four points, no heat is conducted away. Where my fittings screw in, I have internal brass pads attached, to give hold for the threads.

Although my steam pipes are outside, like yours, I get hot steam for my cylinders without the need of all your complicated superheater, as my steam pipes and most of my boiler are in the hot gases from my three lamp flames. My lamp, too, is made of thin tinned iron, and not brass or copper which would conduct heat to my spirit tank. I need little steam, for my cylinders have pistons which really fit and run practically frictionless, whilst yours need graphited yarn packing to make them steamtight. To crown all, I only weigh 1½ lb., whilst you weigh 70 times that amount."

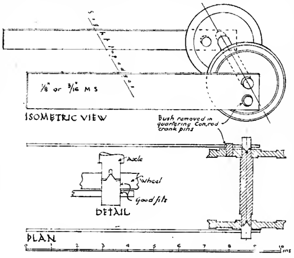
Dignity: But I am properly proportioned, like my big sisters, whilst no full-sized engine ever looked like you—you haven't even a cab, nor a tender!"

Impudence: "What you lack is a little imagination. Now my first owner was a small boy, now, alas, long since grown up. He cared for me, cleaned and polished me until you couldn't find a speck of dust on me anywhere. I was all-in-all to him, the equal of any full-sized engine; he endowed me with a personality because he had imagination and vision. I grant you, you are like your big sisters, and anybody looking at a touched-up photograph of you, would think you actually were a full-sized engine, so you leave nothing at all to imagination." At this point the owner of the two engines, who had been listening to the debate with interest, chipped in with "Now, my two good friends, leave off arguing, for you are both right! What you haven't yet realised is, *that each of you was made for a different purpose*. Being excellent workers, you do your own particular jobs in fine style—and I fancy that's all you need worry about!"

In that last sentence, Mr. Adams fired a shot straight into the middle of the bull's-eye. The moral is obvious, and I heartily commend it, not only to followers of these notes, but to followers of everybody else's notes, too. 'Nuff sed!

A Gadget for Quartering Wheels

Our good friend also sent the accompanying drawing of one of his numerous wheezes, in this instance an easy way of setting coupling-rod crankpins at right-angles. The drawing is practically self-explanatory. Each piece of mild-steel bar has two holes drilled in it; one for the locating centre and one for the crankpin. One bar has the holes drilled parallel with its length, and the other has them drilled at right-angles, or in the case of a three-cylinder engine, at 120-deg. In using the gadget, put the wheels on the axles as far as they will go by hand, setting the cranks as near as possible "by eye"; put the bars in place, with the hole over the crankpin, and the locating centre or spigot in the hole in the wheel boss. Then simply bring the two bars into line, so that the tops are level when sighted across with your eye. Remove the bars and press the wheels home. Mr. Adams used this device to quarter all the wheels on both the Union Pacific 4-8-8-4 recently described, and his 4-12-2 "Caterpillar" type engine, and says it was very handy, doing the job quite well.



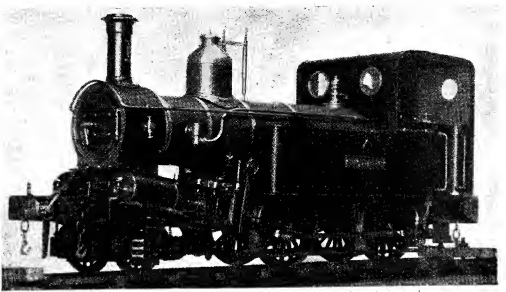
A simple quartering device

Another Unique Job

The Isle of Man is usually associated, in jocular vein, with a certain Mr. Kelly, a three-legged emblem, a cat without a tail, tramway cars hauled by 0-1-1-1-1-0 hay-burners, and—more seriously—with its successful pioneer "Milly Amp" lines, to wit the Douglas and Laxey, and Snaefell Mountain tramways, the latter having gradients as steep as 1 in 12. It was opened for traffic over fifty years ago, and was one of the first electric lines to operate cars over such stiff gradients by ordinary adhesion. A centre rail was provided, but it was for braking purposes only. In the more level parts of the island, traffic was worked by an efficient little steam-operated railway of 3-ft. gauge, with quaint 2-4-0 tank engines, the design of which has remained unchanged from the opening of the line, to the present day. Until Mr. Cecil Wilkinson, of Douglas, started to build a small edition some years ago, I had not heard of these engines ever being copied in small size. Mr. Wilkinson's chassis was described and illustrated some time ago. Having no facilities for boilersmithing, he commissioned Dick Simmonds to do the needful in that line, and also to supply an injector for it. When these came to hand, he got busy and finished the job, with the result you see in the accompanying pictures.

The little "Manx Cat"—as you see, she has no tail whatever—is a pretty faithful reproduction of her not so very big sisters. She is built to

3½-in. gauge, so is a little bigger than "1-in. scale." The overall length is 1 ft. 10 in.; height to top of chimney 13 in. The boiler has a 3½-in. diameter barrel, with "internals" similar to "Juliet," and is fed by the before mentioned injector. It supplies plenty of steam to drive a pair of cylinders ⅞ in. bore by 1½ in. stroke; only a plain four-wheeled passenger car is available as yet, but she will start a seventeen stone load on this without any vestige of a slip, and run with the lever in next notch to middle. The steam ports and valve gear are the same as I described for "Maisie." The latter, by the way, was one of the most popular engines ever described in these notes; so many requests have been made for sets of blueprints for her, that Mr. Donaldson is now busy on the job, and our advertisers will soon be able to supply. Only a few days ago, time of writing, a letter came from my old and esteemed friend "Bill Massive," saying that "Maisie the First" was still performing as well as ever, like many of her numerous big sisters on what was once the Great Northern Railway.



Mr. C. Wilkinson's 3½-in. gauge "Isle of Man" engine

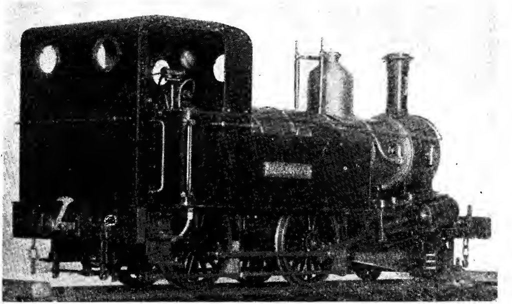
Returning to the little Manx engine, her coupled wheels are 4 in. diameter, and she is finished off as near full-size practice as possible, having a copper-topped chimney, the characteristic Beyer-Peacock dome with spring balances (which are dummy, a direct-acting safety-valve on the inner dome, under the casing, relieving the boiler of excess pressure) central couplers, safety chains, and all the usual impedimenta. She weighs just over a half-hundredweight in full working order. Congratulations to our worthy friend on his very successful reproduction of an unusual type of locomotive.

A Boiler Mystery Explained

A lone hand living up in the North-West corner, sends an account of something that has puzzled him, and wants to know if I can explain it. Well, I'll try! It appears that some time before the war, he built a 2½-in. gauge "Dyak," the 2-6-0 engine which I built, and afterwards fully described, for the competition in which the prize was a silver casket presented by Mr. George Stevenson. Incidentally, the modern "Geordie's" fine 4-6-0 "Wroxham Broad" is still going strong; he sent me a picture of it the other day, along with a useful milling tip which I am passing on in due course. At the time our puzzled friend built his engine, he had no brazing appliance more powerful than a painters' blowlamp, and so he silver-soldered his firebox, and riveted and soft-soldered the outer joints of the boiler. It was his first attempt at boilersmithing, so the net result was, well, not so good as it might have been, shall we say? Anyhow, after stopping up a few leaks which showed up on test, the boiler steamed all right, and the engine was a success, giving our friend many hours of pleasure in running her. Apart from once letting the boiler run dry, which necessitated another application of "Soft Thomas," there were no complaints.

In due course Adolf started his antics, and our friend put aside his locomotive. After the war, however, finances had improved somewhat; he was able to purchase a little extra equipment, among which was one of the "surplus" five-pint brazing lamps which were sold at a cheap rate by a well-known London "bargain store." Now one of the troubles experienced in the original engine, was clinkers accumulating in the firebox, so that the fire needed constant cleaning. Noticing that clinkers only formed in the domestic boiler when the fire was forced, same as on the locomotive, he thought that if he made a boiler with a much larger firebox, and didn't force the fire, his

clinker troubles would be over. He thereupon lengthened the chassis, added another pair of wheels, and turned the engine into a 2-6-2 similar to my "Green Arrow," with a similar-sized boiler. When this was erected, he opened out the blast nozzle a bit, as he said "she didn't half chuck it out" with the original boiler, as he thought there would be no need for such a fierce blast with his wide firebox and large grate area.



A worthy relation of the "three-footers"

To his intense amazement, when he got up steam for the first time, the engine was an absolute washout. She raised steam all right, but wouldn't maintain pressure; the fire burnt a dull red, as he wanted, and there was certainly no signs of clinker, but neither was there enough steam. He went all over the engine part, renewing worn packings and attending to any sources of potential leakage, but still the same result. He couldn't make out at all why a boiler with twice the grate area, and more tube area than the original boiler, should utterly fail to make anything like the amount of steam that the first boiler made quite easily, and wants to know what is wrong.

If our worthy friend has read my notes anything like regularly, he may remember that I have several times stressed the point that it isn't the square inches of heating surface in a boiler that is the determining factor in its steaming ability, but the amount of "therms" applied to the said heating surface. If he tries to boil water in the domestic kettle over a candle, and then puts it on a big gas ring, he will notice some difference; but the heating surface of the kettle bottom remains the same! Exactly the same thing applies to the locomotive boiler. Assuming that the working pressure is 80 lb. per sq. in., which is a normal pressure for a $2\frac{1}{2}$-in. gauge locomotive, the water in the boiler has to be raised to, and *maintained* (very important, that!) at a temperature of 311 deg. Fahrenheit. If the fire is not burning fiercely enough to maintain the water at that temperature when steam is being taken from the boiler, it doesn't matter a bean if the grate area is as big as Hyde Park, and the firebox the size of the Albert Hall—you won't get the steam! Conversely, a little boiler with only a small grate and firebox, will steam like a witch, as the enginemen say, as long as the little fire is burning briskly and giving out its full quota of "therms." My two engines "Sybil" and "Ancient Lights" are specific examples.

It is often stated, and quite correctly, that "so-and-so's engine will stand and blow off with a dull fire." Quite so—but put the injector on, and see what happens! Steam going out, and water far below the temperature of that in the boiler, coming in, reduces the temperature of the water already contained in the boiler; and as the dull fire cannot replace the heat quickly enough, down goes the steam gauge. Put the blower on at the same time, and note the difference. The fire livens up, by virtue of the extra oxygen being drawn through it, it gives out more heat, and the water is not only maintained at the temperature of the steam at blowing-off point, but the incoming water is raised to the same temperature as well. That is, of course, with a properly-designed boiler in which the heating surface is proportionate to the amount of water carried; a ratio which your humble servant found out by actual experiment, for your benefit.

All our friend has to do, to make his boiler

(*Continued on page* 329)

"PUG"—A GAUGE "O"

by R. A. Smith

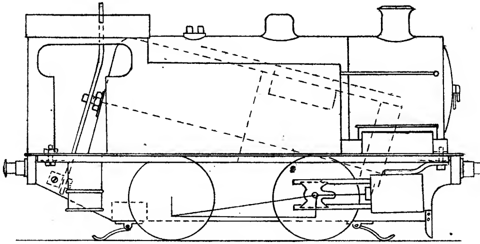
A VISIT to a friend's house, where Junior was operating a gauge "O" electric railway layout, set the "longing bug" in action with young Martyn (Junior in my household) and, as there was a birthday coming, to be followed closely by Christmas, it was decided to see what could be done about it. It was very soon discovered that purchase, (except, perhaps, at a ridiculous price, second-hand) was out of the question, and so the possibilities of making one were investigated. After all, the production of a gauge "O" electric locomotive shouldn't be very difficult to a model engineer, and the work would be a change anyway, from other activities (which includes a $2\frac{1}{2}$-in. gauge "live steamer" to "L.B.S.C.'s" specification). The only doubtful part of the business seemed to be the purely electrical side as, although having the usual model engineer's knowledge of electricity, I am far from being a technical expert in this direction. Later on, as will be detailed, I learned how right I was!

A start was made on the motor unit, as it was thought policy to build an engine around a motor, rather than to build a locomotive and attempt to design and build a motor that could be accommodated within the "shell." Correspondence with various advertisers in THE MODEL ENGINEER eventually produced a very nice cobalt-steel field magnet with the armature tunnel already ground out and with various holes drilled and tapped 6-B.A. in most useful places. The same firm also supplied a set of tri-polar armature stampings to suit. It was intended to mount these up on the shaft and turn to size in the lathe; but, unfortunately, the stampings, as supplied, were a shade too small for this. However, it was found that when the armature was assembled and tried in position it ran quite centrally with approximately 1/32-in. clearance. The general layout of the motor unit can be seen from the sketch (Fig. 1) and the construction was undertaken as follows :—

Main Frame, etc.

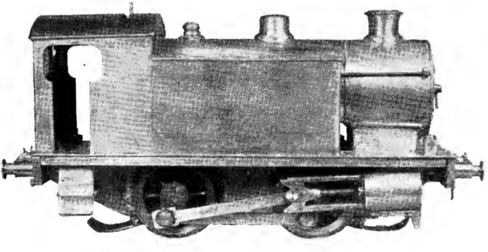
A strip of brass, $\frac{3}{4}$ in. × $\frac{1}{8}$ in., was screwed to the "top" limb of the field magnet, using holes already provided, and at the outside end of this strip a piece of mild-steel, $\frac{3}{4}$ in. × $\frac{5}{16}$ in., was fitted at right-angles, being held in position by two screws which pass through clearance holes in the brass strip. This piece of mild-steel carries the "outer" main bearing—of bronze—which was turned a force-fit in a hole drilled in the correct position. The bearing itself was reamed $\frac{3}{16}$ in.

Careful attention was paid to the "fitting" of this part of the unit as, on the correct location of the various holes, depends the free running of the armature spindle. A hole was already formed in the field-magnet to accommodate the "inner" bearing, and it was decided to make this in such a way that the end-play of the spindle could be adjusted as required. The general idea of the bearing can be seen from the separate sketch (Fig. 2). Once again, the outside of the bearing is turned a force-fit in the hole provided, the bearing itself being reamed 5/32 in. and tapped 2-B.A. to receive the adjusting screw. Adjustment is maintained by means of a washer and suitable lock-nut. The extension on the adjusting screw performs a function to be explained later.



General arrangement of "Pug," the Gauge "O" locomotive

TANK LOCOMOTIVE



Commutator

This important part was made according to a method suggested in THE MODEL ENGINEER Handbook, "Small Dynamos and Motors," and has proved most satisfactory. Briefly, the *modus operandi* is as follows: First, a piece of bronze was turned in the form of an open cylinder ½ in. long, ½ in. outside diameter and bored ⅜ in. The ends are chamfered at an angle of about 45 deg., but *not* to produce a knife edge—this is important—and a slightly rounded corner is to be preferred. Whilst producing this part, the opportunity should be taken to divide the cylinder into three equal segments (using the chuck jaws or change wheels to index) by scratching a line with a fine tool set on edge in the tool holder. The segments are then numbered or otherwise marked so that they can be reassembled in their correct relative positions without difficulty, and finally, sawn apart at the lines already scratched using as fine a saw as possible. The rough edges produced by the saw-cuts should be removed with a fine file, taking care to remove the minimum of material.

Next, two ebonite or hard fibre "stepped" bushes are produced, each drilled and reamed a tight fit on the spindle. The smaller outside diameter should be that of the bore of the bronze cylinder (or very slightly less) and the larger diameter should correspond with the outside diameter of the cylinder (or very slightly more). The steps in these bushes should be undercut to match the chamfer on the bronze segments and the length of the stepped portion should be slightly less than half the length of the cylinder—in this case 15/64 in. The overall length of each bush may be about ⅜ in. Three strips of celluloid, thin ebonite sheet or similar material should be cut to fill in the saw cuts when the commutator is assembled "for keeps." The sketch (Fig. 3) will help to make the construction clear.

General Arrangement of Rotor

The spindle itself was formed from a piece of $\frac{3}{16}$-in. diameter silver-steel, 3½ in. long. A collar, approximately ¼ in. diameter and ¼ in. long, was pinned near one end and the other end was turned down to 5/32 in. diameter for approximately ⅜ in. and a further ⅜ in. screwed 40 t.p.i.

The rotor was then assembled as follows:—First of all, the two-start worm (which, with its wheel of 24 teeth was to form the transmission) was drilled and reamed $\frac{3}{16}$ in. and threaded on the spindle to abut against the collar. Incidentally, this worm and wheel is of some aluminium alloy, and once formed part of some item of aircraft equipment. It is a beautifully produced pair of wheels and, although of relatively soft material, seems to be standing up well.

Next comes a ¼-in. spacing washer and then the "bits" of the commutator. The assembly of this made me wish for a few extra fingers! If the fibre or ebonite "bushes" are a fairly tight fit on the spindle it will be found that the parts will stay in position moderately well. Then another spacing washer—this time about ⅜ in. long—and then the "pack" of armature laminations followed by a washer approximately 3/32 in. thick. The whole lot is finally secured by a 40-t.p.i. nut. Before tightening up for "keeps," the commutator should be adjusted on the spindle relative to the armature so that its segments are in line with the poles of the armature. The easiest way to ensure that this position is correct is to "sight" along the spindle and line-up the saw-cuts (now filled in) in the commutator with the 60 deg. ridges which will be seen at the bottoms of the spaces between the poles. This lining-up is important as, if one is "advanced" or "retarded" relative to the other, it may well be found that speed in reverse is in excess of that in forward or vice versa.

The next item is to smooth the rough edges from the pack of stampings and then thoroughly insulate all the winding spaces. This is another item which must not be scamped, because a short circuit to the spindle in this type of motor (where the frame, etc., is used as a path for the starting in both directions. I have found that, if the engine "jibs," a flick of the reversing switch over to the other direction and then back to the desired position is an unfailing remedy. Details of the way the armature is wound will be aparent from the diagram (sketch Fig. 4).

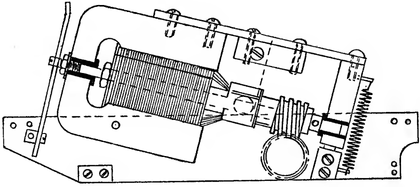


Fig. 1

current) is even more serious than in the case of an ordinary motor where the frame is not so used. In this particular case, the insulation was carried out with two thicknesses of Empire tape fixed with a liberal application of shellac varnish. A word of warning here :—Don't use varnish made from commercial shellac dissolved in ordinary methylated spirit! It is very liable to

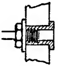


Fig. 2

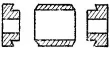


Fig. 3

have a slightly acid reaction and may, in consequence, play havoc with the windings in due course. Use only the real stuff, procurable from electrician's stores.

Several windings have been tried, some purely for experimental purposes and others which have been necessitated by various burn-outs and "shorts" caused by divers reasons. (Among these may be mentioned a "short" caused by a jagged edge of a lamination cutting through the insulation, and a burn-out caused by a small piece of solder short circuiting two of the commutator segments.)

The winding at present in use consists of 70 turns of 26-gauge enamelled wire on each pole. (Sketch of rotor Fig. 5.)

When the rotor is completed the insulation should be tested. I suppose a "megger" would be used for this by an electrician, but I used a 60-volt dry battery and a cheap pocket voltmeter. "Tie" the armature spindle to the negative end of the battery, connect the positive terminal of the voltmeter to the positive end of the battery and attach a "prod" to the other voltmeter terminal. Touch the "prod" on to each commutator segment in turn and if the voltmeter needle flickers at all, you've had it! Strip the

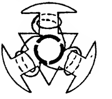


Fig. 4

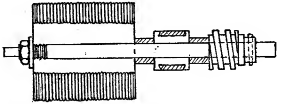


Fig. 5

The style of winding adopted is, I believe, called the "series" type and I have heard it described as "pernicious." However, it was the only way I knew of winding a three pole armature and has, so far, proved quite satisfactory except that the motor is not 100 per cent. self-

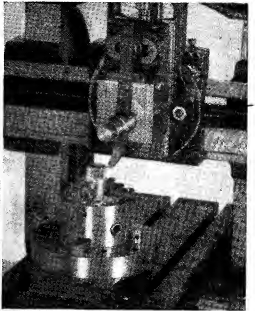
winding from the armature and start again. When the rotor has been tested and found O.K., it should be assembled in the motor frame to make sure that it revolves freely. Then—and only then—pass to the brush gear.

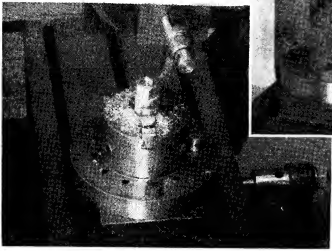
(*To be continued*)

Planing a Hexagon

NO originality is claimed for the method of carrying out the operation illustrated here, but it may be of interest to readers faced with a similar problem. The machine used was a Senior hand planer, but a small shaping machine would have been even more convenient; a milling machine, either of the vertical or horizontal type, could be adapted to produce a similar result, or even, in certain circumstances, a lathe, if sufficient height over the cross-slide is available to take the indexing fixture.

This fixture is the main centre of interest in the particular instance, and consists of a 3-in. self-centring chuck mounted on a disc by its backplate attachment screws, and the latter in turn mounted on a baseplate by a pivot bolt.





(Above). The indexing fixture set up on bed of planer (Left). A close-up of the operation in progress

Twelve equally spaced holes in the disc, in conjunction with a single hole in the baseplate, enable the chuck to be located by a dowel-pin in any of twelve positions, and means of pulling it down hard against the baseplate are provided to take the cutting stress off the indexing gear.

With this arrangement, divisions of 2, 3, 4 or 6 can be obtained, covering a wide range of requirements for the production of regular polygons and other geometrical shapes, but it is, of course, practicable to use discs with any required number of holes, or even a worm indexing device if necessary. A simple fixture of this type will be found extremely useful and can, if desired, be made to take one of the lathe chucks; for some classes of work a small collet chuck is most convenient, but large diameter work may in some cases be clamped direct to the indexing disc.—"NED."

"L.B.S.C."

(Continued from page 325)

steam, is to reduce the size of the blast nozzle until he has enough draught on the fire, to maintain his boiler temperature at the said 311 deg., as his valves are set to blow at 80 lb. Whether the fire will burn fiercely enough to form clinkers as before, is a matter for experiment. It may, and it may not; the larger boiler, with its bigger water capacity, and heating surface to match, should certainly be more stable, and as the cylinders will only take the same amount of steam that they took from the small boiler, the larger one should not have such a tendency to drop in temperature as the small one did, and the bigger fire should be able to supply the "therms" with less exertion, therefore making less clinker. But the point all new recruits must bear in mind is, that it is boiler temperature, and not mere square inches of heating surface, that keeps the needle of the steam gauge where it should be when the engine is running.

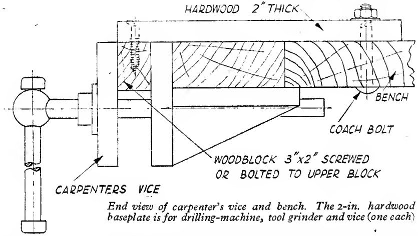
Economising Workshop Space

by R.N.L.

FEW model engineers have workshops which are large enough for their needs, so any devices which make for economy of space may well be welcomed by those who have caught the "spring cleaning" fever and are contemplating some rearrangement of present layout, or to the beginners who are scheming to squeeze a "palace of engineering" into some odd corner of the garage or outhouse.

months of experimenting, and the result has been (to me at least) so satisfactory that I have added the following few suggestions in the hope that they may be of interest to others.

Measuring instruments of one kind or another take pride of place in everyday usefulness, but by reason of their comparatively fragile nature and high cost, they demand the protection of a drawer. So I made a shallow drawer to



End view of carpenter's vice and bench. The 2-in. hardwood baseplate is for drilling-machine, tool grinder and vice (one each)

When I was laying out my present workshop I was faced with the problem of providing a bench of at least six feet in length and unencumbered with any excrescences, for besides model engineering, I indulge in fishing-rod making, and this requires a long and clear carpenter's bench. My lathe is mounted on a stand of its own, but drilling machine, vice, and tool grinder, all demanded bench-room, and there was no room to spare on my one and only bench. The solution seemed to be to make those items quickly detachable, and as the bench had two carpenter's vices already fixed, they seemed to present a feasible means of clamping my accessories to the bench.

The sketch will indicate how this was accomplished and with the addition of two long carriage bolts, vice, hand drilling-machine and grinder have proved quite adequately secure and yet very quickly detachable. When not in use, these accessories are stored on a shelf under the bench, and carpentry can proceed on its uninterrupted way.

Storing Small Tools

The same need for economy in space compelled me to consider very carefully what small tools were in most general use and required to be immediately to hand in open racks or clips, and what others could best be stored in drawers or cupboards. This aspect of my workshop layout took considerable thought and some

fit under the bench, and with the aid of seven pounds of plaster of paris, made nice little beds for them to lie in. There, snugly, lie my micrometer, depth gauge, and dial indicator, combination set, squares and calipers, two scribers, sundry rules, and that invaluable adjunct of accurate measurement, a watchmaker's glass.

On the wall and in the window recess behind my bench, there hang in racks and clips, my hammer, three centre punches, four screwdrivers, ten files (with handles), four pairs of pliers, two old tooth brushes and four round "spout brushes." On a shelf repose my two sets of twist drills and various cigar boxes into which are fitted (more plaster of paris) taps and dies of B.A., B.S.F., and Whitworth threads, and their attendant tap wrenches and diestocks.

These comprise the tools which I find most frequently in use and for which my hand now stretches forth automatically and without conscious effort, for I pride myself that I have formed the admirable habit of replacing a tool in its appropriate rack each time I use it, and do *not* lay it on the bench or lathe-bed, to be lost to sight, though to memory dear.

Without being considered a faddist, I hope I may be allowed to recommend similar action in design to all who have, by force of circumstances, to exercise economy of space as well as that precious factor time, which is so often squandered, in the search for some small tool which, "I had in my hand a minute ago."

IN THE WORKSHOP

by "Duplex"

7—Tool Equipment for the Lathe

FOR those who are fortunate in obtaining a new lathe, equipped by the makers with the necessary chucks, one of the first questions to arise after the lathe has been installed is the provision of a set of turning-tools for use in the slide-rest. Formerly, this problem was solved, or partly solved, by purchasing a set of twelve or more forged tools made of carbon or high-speed steel, supplemented, perhaps, by one or more tool-holders equipped with removable tool-bits.

If we agree that fundamentally lathe tools should be capable of being easily sharpened to the correct cutting angles, besides being readily interchanged and set to the proper height, then the above solution will fall far short of what is required. The forged tool seldom has a flat base and so may rock on the grinding rest; moreover, tools of the swan-neck variety and those with irregularly-shaped heads may offer a tiresome problem when it comes to sharpending them accurately; for although tools were formerly sharpened by the off-hand method, nowadays, the practice of accurate angular grinding is rightly gaining ground even in the small workshop. Furthermore, these awkwardly-shaped tools require individual attention for setting to height by means of packing strips, for even the American pattern tool-post is not entirely satisfactory in this respect, as the cutting angles presented to the work alter as the tool point is tipped up or down, as the case may be. Tool-holders certainly provide a ready means of height setting, but they are at times clumsy to use in the small lathe, and the very short length tool bits used in the smaller holders are difficult to handle when being ground. Nevertheless, tools of special form undoubtedly have their uses at times and should not be entirely disregarded.

Again, a full-length lathe tool made of high-speed steel is expensive, and the greater part of the outlay is expended in the tool shank where it is quite unnecessary.

On the other hand, we can buy from the tool vendor short lengths of special high-speed steel, ground on all surfaces and correctly heat-treated to ensure the highest cutting efficiency. These tools are made for use in the larger tool-holders and more especially for equipping automatic production machines, where tool failure or frequent resharpening would not be tolerated on financial grounds. Many brands of special steel are used in these tools, and as they are produced by well-known steel manufacturers, this alone is a sufficient guarantee of their quality.

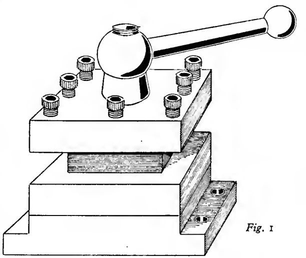


Fig. 1

For use in the small lathe a standard tool of $\frac{3}{8}$ in. square section and 3 in. in length will be found suitable, but other sizes, ranging from $\frac{3}{16}$ in. by $2\frac{1}{2}$ in. to $\frac{3}{4}$ in. by 5 in. or more, are obtainable.

As has been said, these tools are ground on all surfaces, and this ensures that they lie flat on the grinding rest while the cutting edges are being ground to the required angle. Although these tools can, if desired, be mounted in the ordinary tool-post and set to height by means of packings, this procedure may be somewhat tiresome and time wasting when several tools are required in quick succession for a particular turning operation.

The Tool-post Turret

To obviate this constant changing and re-setting of tools, a tool-post turret carrying four tools can be employed, and by this means the accurately set tools can be brought into use as required with the minimum of delay; moreover, once the height of each tool has been correctly set it will remain so until regrinding becomes necessary.

If, in addition to these four tools, two more are mounted in a back tool-post, we have a battery of six tools ready for immediate use which should be adequate for all ordinary work.

The Myford tool-post turret, illustrated in Fig. 1, is of simple straightforward design for accommodating four tools, which are individually located in four positions by means of an index pin as the turret is rotated after releasing the clamping lever. This turret replaces the normal tool-clamp, and is secured to the upper surface

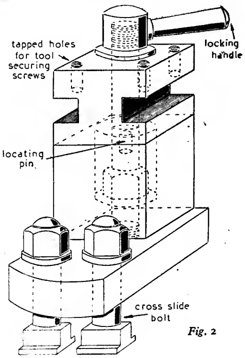


Fig. 2

of the top slide by four screws. Standard cutter-bits of $\frac{1}{4}$-in. square section and $2\frac{1}{2}$ in. long are suitable for use as turning tools.

For the $3\frac{1}{2}$-in. Myford Drummond type lathe Messrs. Myford make a rather more elaborate four-tool turret for attachment to the standard tool-post pivot member, which readers may remember is formed integrally with the top slide casting.

In this model a hardened steel internal ratchet device, housed within the turret body, provides for the location of the revolving turret-head at eight stations.

This indexing mechanism is fully enclosed and protected, and moreover, when the clamping lever is released and the turret-head rotated, chips cannot enter to interfere with the setting, as the turret remains throughout in close contact with its base. In this case, standard tool-bits are also used, 3 in. length and of $\frac{3}{8}$-in. square section.

In addition to these tool-post attachments, turrets are made to bolt directly to the upper surface of the cross slide; but when these are fitted the operator is deprived of the use of the top slide.

The Back Tool-post

The fitting of a second tool-post at the rear of the cross slide not only provides for the mounting of one or two additional tools, but also enables these tools to be used to better advantage.

It is well recognised that when a heavy cut

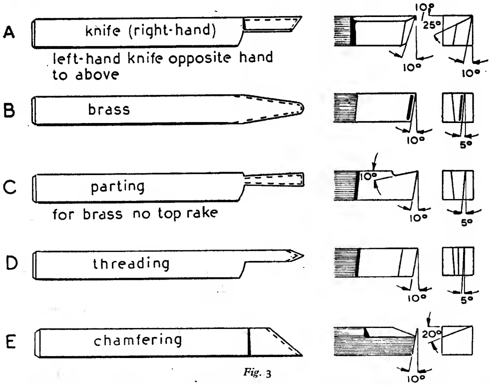


Fig. 3

is taken with a tool such as a parting-tool, this operation is performed better when the tool is mounted upside-down and with the lathe rotating in its normal direction Some lathe-makers supply a back tool-post for this purpose machined from a casting and mounting a single tool. If a broad cut has to be taken with a chamfering tool, as for example when machining

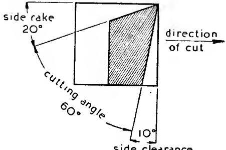


Fig. 4

large washers, this operation is also best undertaken with the tool upside-down. In order, therefore, to mount both a parting and chamfering tool at the rear of the lathe, the writers' have made a back tool-post with a small two-station turret-head. This device is illustrated in Fig. 2, and it will be seen that the base is secured to the lathe by means of two T-headed bolts engaging a T-slot in the cross slide. A central shouldered bolt secures the body portion to the base, and its upper end carries the lever nut for clamping the turret-head.

The ¼-in. square tools are clamped in their housings in the usual way by means of square-

Lathe Tools

The tools described in books of reference are often of the commercial type, formed to withstand the great stresses involved in removing the maximum amount of material in the shortest time, in order to comply with the requirements of industrial production. At the other end of the scale is the user of a treadle lathe, who knows only too well the extra work required to force a blunt or heavy duty tool along the work. The difference, here, lies mainly in the cutting angles used in the two cases ; for where the tool is subjected to much stress the cutting angle is correspondingly increased, but for light work, where free cutting is desired, the angle of the cutting edge should be reduced and made more chisel-like so that it tends to shave the metal rather than to prise off the chips.

A further advantage of using a slender cutting edge is that less heating is caused and distortion of the work is thereby avoided. When using heavily-built production lathes, the length of the tool's cutting edge in contact with the work can be ample to distribute the cutting stresses ; but in the lighter types of lathes, where there is less rigidity in the mandrel and machine slides, chatter and inaccurate work may result if the tool's contact with the work surface is too extensive.

Experience with any particular lathe will show the best form of tool to use and the area of tool contact allowable before chatter or irregular finish develops. If, on the other hand, the tool is too finely pointed, not only will the tip be weakened but what amounts to a screw thread will be cut on the surface of the work, and to obviate this the rate of traverse must be reduced, or the point of the tool may be slightly rounded to give a smooth finish to the work.

Furthermore, the less the tool contact, and with

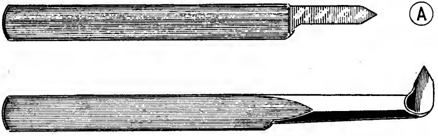


Fig. 5

headed screws, whilst the two stations are indexed by a register pin, attached to the turret-head and engaging either of two holes in the body.

This compact device interferes so little with ordinary turning operations that it is normally mounted in place, and when making a number of small parts it is of the greatest service in forming chamfers and parting-off without loss of time. The attachment is, however, readily removable if required by merely slackening the two securing nuts and sliding it out of the cross slide T-slot.

Now that we have six tool mountings available, the next step is to equip them with tools suitable for carrying out all ordinary turning operations.

it the less the work and the machine are stressed, the greater will be the accuracy of machining attained. It is for this reason that, although heavy roughing cuts may be taken to save time, a fine cut is required for finishing the work.

The Knife Tool

This tool, shown in Fig. 3A, is perhaps the most generally useful and the form most used in the small lathe engaged in the more usual turning operations. To obtain free cutting when turning mild-steel, the cutting angle, that is to say the angle the upper surface makes with the forward side surface, should be ground as shown in Fig. 4 to an angle of some 60 deg., which with a

side clearance of 10 deg. and a side rake of 20 deg. makes the total up to 90 deg. It will be apparent that, as the tool cuts mainly on its forward side, most of the cutting stress is taken by the mandrel thrust-bearing, and the mandrel journal-bearings are largely relieved of load ; nevertheless, the point bears on the work, and if this edge is broadened so that it makes too great a contact with the work, chatter may result.

In practice, it is usual to form a small facet or straight-edge at the tip of the tool, or to slightly round its point ; this edge then determines the diameter of the work turned, and, as it removes only a small amount of metal at each traverse, a good finish is imparted to the surface.

In addition, the rounded tip enables the tool to be used for taking light facing cuts when finishing shoulders and other flat surfaces.

Brass-Turning Tool

As illustrated in Fig. 3B, this tool is formed without top or side rake, that is to say its upper surface is flat and has no backward slope in either the long or the transverse axis. A clearance angle of some 5 to 10 deg. should be given to the side and front cutting edges. It may be found that, when turning some brass alloys, better cutting is obtained if a top rake of some 5 deg. is given, but in the case of hard bronze a negative top rake may be required to prevent digging-in, or hogging, as the Americans aptly term it. Negative top rake is the reverse of normal top rake, and means that the end of the tool is ground to slope downwards towards the cutting edge.

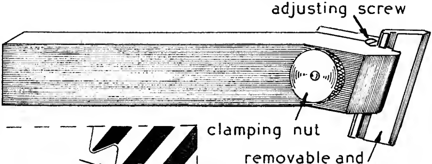


Fig. 6

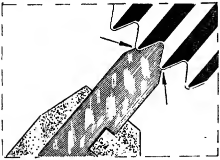


Fig. 7

The Parting- or Cutting-off Tool

This tool, shown in Fig. 3C, is used, as its name implies, for parting-off cylindrical work in the lathe, and as it may impose considerable stress when cutting and has a tendency to jam in the work, it is best employed in the upside-down position with the lathe running at a slow or moderate speed.

Tools with a broad tip may be given a side clearance of 5 deg., but in the case of narrow-edged tools, which are generally to be preferred, 3 deg. of clearance should be used, otherwise the tool may be unduly weakened. The amount of front clearance should also be made to suit the tool, for while 10 deg. may be allowed in a broad-pointed tool, 5 deg. should not be exceeded when the cutting edge is narrow.

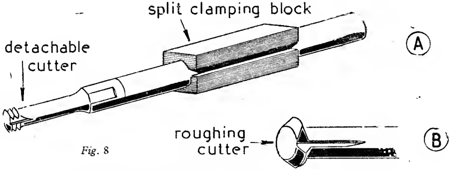


Fig. 8

The side view of the tool suitable for steel shows a top rake, or slope behind the cutting edge, of 10 deg., which ends in a curved surface by means of which the chips are made to come off in the form of a coil, thus preventing their jamming in the work. The tool used for parting brass

has no top rake, as this would cause digging into the work.

In the view of the upper surface, it will be seen that the shaped portion of the tool narrows from the cutting edge backwards; this is to prevent it from jamming in the cut as it is fed forwards, but in the case of a narrow tool this reduction of breadth must be small, otherwise breakage will be liable to occur at the narrow neck, especially should the tool happen to jam in the work.

Fig. 9

The Chamfering Tool

The tool shown in Fig. 3E, is used for bevelling the ends of shafts or screws and the edges of washers, usually to an angle of 40 to 50 deg. For turning steel, free cutting is ensured and a good finish is imparted to the work if a rake of some 10 deg. or more is given to the cutting edge, but for brass this rake should be omitted. In either case, a clearance angle of 10 deg. should be allowed between the cutting edge and the face of the work. As has been previously pointed out, these tools cut better in the inverted position when machining broad surfaces.

Screw Threading Tools

In Figs. 3D and 5A a tool is shown suitable for cutting either right- or left-hand external threads. The included angle of the point is ground with the aid of a threading gauge to match the form of thread being cut. It will be seen that no top rake is given, for if it were, the correct thread angle would not be formed unless the angle of the tool point were correspondingly altered; however, as in the previous instances, front and side clearances are provided. The internal counterpart of the external threading tool is depicted in Fig. 5B, and here the form of the tip is similar, except that the heel of the tool below the cutting edge is well backed off to clear the work when threading holes of small diameter.

The Whitworth thread, which is generally used in this country, is formed with the crests and bottoms of the threads rounded; and it will be apparent that this form cannot be imparted to the work by means of a simple V-pointed tool as described above. To overcome this difficulty and to form threads of the true Whitworth form, Messrs. Jones and Shipman manufacture form-threading tools for both outside and inside screw-cutting.

The external threading tool, shown in Fig. 6, comprises a tool-holder fitted with a clamping-piece and a screw for holding the detachable cutter-bit; in addition, a screw, carried in the head of the holder and engaging threads formed on the back of the cutter, provides a ready means of adjusting the tool height and at the same time secures the cutter while in operation. The drawing, Fig. 7, depicting the profile of the cutting point, shows that the tip of the tool is rounded and its flanks, where indicated by the arrows, are shaped to impart the correct form to the thread at its bottom and crest respectively. It should be noted that the cutter when mounted in the holder is at an inclination of 15 deg. in order to provide both front and side clearance; the upper surface of the cutter, however, is horizontal and without top rake so that the profile of the tool is correctly reproduced on the work.

This horizontal surface must be strictly preserved when it is ground to resharpen the tool.

The corresponding internal threading tool, illustrated in Fig. 8A, consists of a detachable cutter screwed into a bar, which is securely held in its split block when clamped in the lathe tool-post. The actual cutter represents an internal thread-chasing tool and can be readily resharpened when required by grinding the radial cutting face.

To relieve the strain on this tool, which when cutting is in contact with the work over some two and a half threads, it is advisable to reserve it for the final finishing of the thread, and to carry out the preliminary machining with the single-tooth roughing cutter shown in Fig. 8B.

Boring Tools

The single-piece forged boring tool, rather similar in appearance to the internal threading tool shown in Fig. 5B, has now been largely displaced by the boring bar, such as the "Nulok" depicted in Fig. 9, which carries a round section tool-bit at its tip, and is secured in the lathe tool-post by means of a split clamping block. This tool has the advantages that the tool-bits are readily renewed, and also the bar can be adjusted as required to reduce the overhang of the tool to a minimum.

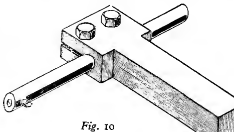


Fig. 10

It may be found in some lathes that when boring small holes, there is difficulty in advancing a tool of this type up to the lathe centre-line; and to obviate this, a holder of the form illustrated in Fig. 10 can be used to carry the boring bar which can then be readily set to the centre of the work.

Tungsten Carbide Tools

Commercial engineering production has been greatly increased by the use of tools tipped with

(*Continued on next page*)

Scale Conversion Table

by N. S. Wilde

OFTEN when modelling, it is a somewhat laborious task to reduce the full-size dimensions to the scale required.

The accompanying table is to do away with this work, and let the modeller get started.

It can be seen at a glance how the table is used.

For instance, should the modeller desire a model ⅛th full size, or 1½ in. to 1 ft., all one has to do is to read down the left-hand columns headed "Scale," and when ⅛th full size is reached, read across until the desired full-size dimension is reached. The dimension at this intersection is the scale dimension to be used. e.g.

Scale : 1½ *in. to* 1 *ft.*

Required : *Scale dimension of* 9 *in.*

7th line down, read across to 9 in. column and read off 1⅛ in.

Scale : ⅛ *in. to* 1 *ft.*

Required : *Scale dimension of* 4 *in.*

12th line down, read across to 4 in. column and read off 0.167 in.

The dimensions given in decimals are to the nearest 0.001 in. Also, fractions of actual dimension can be derived by interpolation.

SCALE	SCALE	1/2"	1"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	4 1/2"	5"	6"	7"	8"	9"	10"	12"
3/4 FULL SIZE	9" ≡ 1 FOOT	3/8"	3/4"	1 1/8"	1 1/2"	1 7/8"	2 1/4"	2 5/8"	3"	3 3/8"	3 3/4"	4 1/2"	5 1/4"	6"	6 3/4"	7 1/2"	9"
1/2 "	6" ≡ "	1/4	1/2"	3/4"	1"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	3"	3 1/2"	4"	4 1/2"	5"	6"
3/8 "	4 1/2" ≡ "	3/16	3/8"	9/16"	3/4"	15/16"	1 1/8"	1 5/16"	1 1/2"	1 11/16"	1 7/8"	2 1/4"	2 5/8"	3"	3 3/8"	3 3/4"	4 1/2"
1/4 "	3" ≡ "	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	3"
3/16 "	2 1/4" ≡ "	3/32"	3/16"	9/32"	3/8"	15/32"	9/16"	21/32"	3/4"	27/32"	15/16"	1 1/8"	1 5/16"	1 1/2"	1 11/16"	1 7/8"	2 1/4"
1/6 "	2" ≡ "	·083"	·167	1/4"	·334	·417"	1/2"	·583"	·668"	3/4"	·834"	1"	1·166"	1·336	1 1/2"	1·668"	2"
1/8 "	1 1/2" ≡ "	1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 1/2"
3/32 "	1 1/8" ≡ "	3/64"	3/32"	9/64"	3/16"	15/64"	9/32"	21/64"	3/8"	27/64"	15/32"	9/16"	21/32"	3/4"	27/32"	15/16"	1 1/8"
1/12 "	1" ≡ "	·042"	·083"	1/8"	·167"	·208	1/4"	·294"	·334	3/8"	·417	1/2"	·583"	·668	3/4"	·834"	1"
1/16 "	3/4" ≡ "	1/32"	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	9/32"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
3/64 "	9/16" ≡ "	·022"	3/64"	·066"	3/32"	·110"	9/64"	·154"	3/16"	·198"	15/64"	9/32"	21/64"	3/8"	27/64"	15/32"	9/16"
1/24 "	1/2" ≡ "	·021	·042	1/16"	·084"	·104	1/8"	·147"	·167"	3/16"	·208"	1/4"	·292"	·334"	3/8"	·417"	1/2"
1/32 "	3/8" ≡ "	1/64"	1/32"	3/64"	1/16"	5/64"	3/32"	7/64"	1/8"	9/64"	5/32"	3/16"	7/32"	1/4"	9/32"	5/16"	3/8"
1/48 "	1/4" ≡ "	·011	·021	1/32"	·042"	·052"	1/16"	·074"	·084"	3/32"	·104"	1/8"	·146"	·167"	3/16"	·208"	1/4"
1/64 "	3/16" ≡ "	·008"	1/64"	·022"	1/32"	·039"	3/64"	·055"	1/16"	·069"	5/64"	3/32"	7/64"	1/8"	9/64"	5/32"	3/16"
1/96 "	1/8" ≡ "	·006"	·011	1/64"	·021"	·026"	1/32"	·037"	·042"	3/64"	·052"	1/16"	·073	·089"	3/32"	·104"	1/8"
1/192 "	1/16" ≡ "	·003"	·006	·008"	·011"	·013	1/64"	·019"	·021"	·022"	·026"	1/32"	·037"	·045"	3/64"	·052"	1/16"
1/384 "	1/32" ≡ "	·0015"	·003	·004"	·006"	·007"	·008"	·009"	·010"	·011"	·013"	1/64"	·019"	·023"	·022"	·026"	1/32"

In the Workshop

(*Continued from previous page*)

tungsten carbide. This is an extremely hard but rather brittle synthetic substance, which not only allows turning speeds to be more than doubled, but also retains its sharpness and cutting properties when machining the most resistant materials. In the small workshop a tipped tool of this type may be used to remove the scale from castings, and even to machine hardened steel parts such as ball-bearing races; moreover, cast-iron can be turned at speeds not possible even with high-speed steel tools. Nevertheless, care must be taken not to overstress and chip the brittle cutting edge, for this will necessitate regrinding on a special type of wheel, followed by a finishing process carried out on a cast-iron wheel impregnated with diamond dust.

Editor's Correspondence

"Roaring" Boilers

DEAR SIR,—Further to recent remarks by your contributor, "L.B.S.C.," about the roar set up in a firebox when the fire is getting thin. My first experience of this was as a schoolboy; when on vacation, I was driving a Wallis & Steevens light steam tractor (one of a fleet of road engines, owned by my father, who was a heavy haulage contractor operating in the Staffordshire Potteries). The "Five Towns" have some notorious hills and while climbing one of them, the engine began a most terrifying roar, which really scared me, as it was my first experience of this sort of thing; but by no means my last. I found that by thickening the fire, and/or partly closing the regulator, thereby reducing the draught, the phenomenon ceased. The "Professor," Mr. Maddock, knew the above engine very well, as it did a number of jobs at the noted Newcastle Street works.

Other engines, and the works boiler also, I found would "roar" on occasions, the compounds, having a softer blast, being less inclined to do so. Later on, I modified the ashpan of one of my Dad's Foden overtype steam wagons by fitting a slide in the bottom for quick cleaning out, and I found that when travelling with the slide out, to liven up the fire quickly, this wagon would start the offensive noises, though a 2-cyl. compound engine is fitted to this firm's overtype. In many thousands of road miles with a number of Foden overtypes, I do not recall any of them, except that with the modified ashpan, ever starting to "roar." With a clean fire, not too thick, and the blower on fairly hard, certain engines would set up a terrific fuss, vibrating the air, and rattling windows a considerable distance away.

Let your readers judge for themselves, whether "L.B.S.C." is right in advocating big bores and large ports, in view of the following observations.

In my father's fleet was a Tasker engine, which would do a tremendous amount of work, at a ridiculously low boiler pressure. This engine would noiselessly fluff its way across the yard with the needle just away from the zero stop and about 27 lb. per sq. in. actually available. Other engines could not traverse the same ground with less than 60 lb. per sq. in. showing, and it was said by my dad that the Tasker could be moved if the water was boiling, which appeared to be true, as at very low pressure, and wide-open throttle, priming occurred and boiling water was blown up the funnel.

When I became older and saw this engine opened up for repairs, I found that the designer of that engine knew much about "free and easy aspiration," for he had given its cylinders $\frac{1}{2}$ in. bigger bore than other engines in the same class by other designers, and from the regulator port to the blast nozzle orifice the maintained cross-sectional area was greater by about a third than any similar engine I have ever seen. I handled that engine myself, and found it to be easy steaming, quite economical, and never necessary to wait for full blowing-off pressure before ascending a hill owing to its prodigious pulling power.

Now, coming to models, my own loco had such a reserve of power that I decided to reduce its bore by fitting a $\frac{1}{16}$-in. liner, in the hope of considerably increasing distance of run on each filling of water. Since its alteration it has never given such good results as previously, and I intend to open it up again to its original bore, being very disappointed with its present performance.

Yours faithfully,

Blackpool. ARTHUR WEDGWOOD.

Black Finish

DEAR SIR,—I have read with interest Mr. Maskelyne's article on the marine engine, built by Lieut. W. T. Barker, and in particular his reference to the difficulties encountered in producing a suitable black finish on the cylinder lagging.

I have had a similar problem in connection with lagging the piston-valve cylinders on my $\frac{3}{4}$-in. scale L.M.S. "Pacific" locomotive.

As planished blue steel is apparently unobtainable, I made the lagging-sheets from 0.015 in. duralumin, and had some finished "Black Anodic Dye." This gives a corrosion-free surface of a very dark-blue tint—almost black.

In my case the lagging-sheets are secured by $\frac{1}{8}$-in. wide strips of similarly treated material, held on by 12-B.A. round-head screws, oil-blued to match. The effect is very pleasing. Dural sheets with this finish should look well on the boiler lagging.

Unfortunately, the process is not a practical proposition for the home workshop, but any commercial plating-plants should be able to do it quite reasonably.

Yours faithfully,

Cheltenham. H. E. WHATLEY, A.R.Ae.S.

Lathe Headstock Bearings

DEAR SIR,—May I point out to reader Langer *re* his letter in the March 4th issue that, to my knowledge, *all* "Timken" roller cone bearings are, or should be, pre-loaded. I stand to be corrected, of course, but when fitting "Ford" crown wheel assemblies I have pre-loaded between 0.001 in.-0.006 in. . . . Quite a pressure!

On "Mack" heavy trucks, road-wheels having cone roller bearings *must* be locked up solid—then released "two flats"—still a pressure!

Yours faithfully,

Plymouth. ROBERT C. ELLIS.